MODELLING NON-LINEAR STRESS RELAXATION OF POLY(ETHYLENE TEREPHTHALATE)

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Introduction

In a stress relaxation test a deformation is quickly applied to the material, which subsequently remains constant, while the tension decreases over time. In this phase we will consider the absence of viscous flow, which will be taken into account in later works.

The models presented in the literature to interpret the behavior of polymeric materials at stress relaxation stresses are essentially empirical or semi-empirical, not taking into consideration the physical (molecular) mechanisms responsible for the viscoelastic behavior. In the present study, a previously developed molecular model [1, 2] was applied with the purpose of describing the stress relaxation of polymeric materials, at various deformations and different temperatures, with and without previous heat treatment.

Results

The model for the stress relaxation modulus described by the authors [1, 2] leads to the expression:

$$E_r(t) = E_\infty + (E_0 - E_\infty)\frac{\int_{\ln t}^{+\infty} e^{-[b\ln(\theta/\theta^*)]^2}\, d\ln\theta}{\int_{\ln\theta_1}^{+\infty} e^{-[b\ln(\theta/\theta^*)]^2}\, d\ln\theta} = E_\infty + (E_0 - E_\infty)\frac{1+erf\left[b\ln\left(\frac{\theta^*}{t}\right)\right]}{1+erf\left[b\ln\left(\frac{\theta^*}{\theta_1}\right)\right]}, \quad (1)$$

where $b=b_0/\ln(\theta^*/\theta_1)$, θ^* is an average relaxation time, and θ_1 minimum relaxation time.

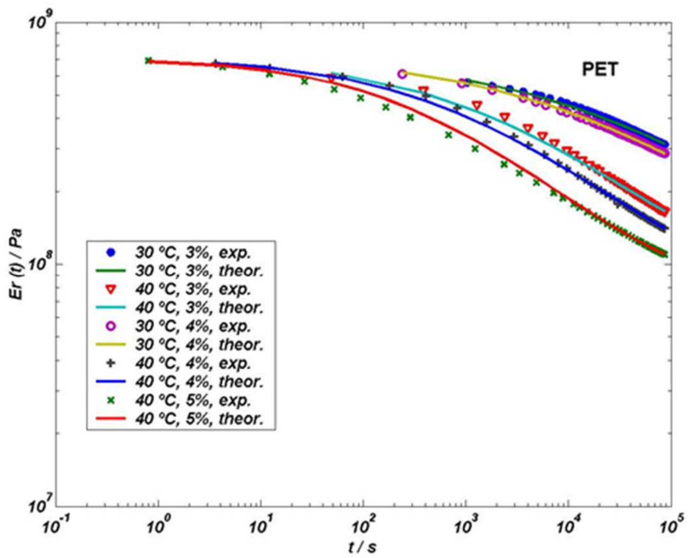

Figure 1. Adjustment of the relaxation modulus data for Poly(ethylene terephthalate) (PET) at 30 and 40 ºC using equation (1).

1. J.J.C. Cruz Pinto; J.R.S. André *Polym. Eng. Sci.* **2014**, 54, 2, 404.
2. J.J.C. Cruz Pinto; J.R.S. André *Polym. Eng. Sci.* **2016,** 56, 3, 348.